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CABLE, ELECTRO-MECHANICAL TOW TYPE AN/SQA-13 FROM USS SAUFLEY (--ETC(U)

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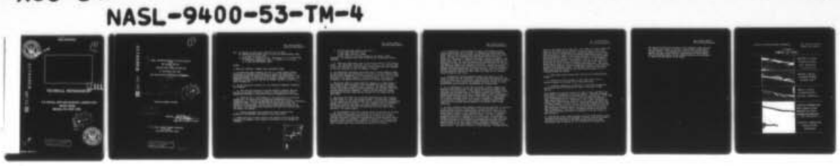

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TECHNICAL MEMORANDUM

U.S. NAVAL APPLIED SCIENCE LABORATORY
NAVAL BASE
BROOKLYN 1, NEW YORK

USNASL-9110-P-1J

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CABLE, ELECTRO-MECHANICAL TOW TYPE AN/SQA-13
from
USS SAUFLEY (DE 465)
for
VARIABLE DEPTH SONAR APPLICATIONS.

SF 011-03-09, TASK 8366

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LAB PROJECT 9400-53, TECHNICAL MEMORANDUM 4

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PHYSICAL SCIENCES DIVISION

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247 550 LB

Ref: (a) BUSHIPS ltr 9670/13 Ser 689A-464 of 12 Sep 1961
(b) FONECON between USNUSL (933, S. Gross) and NAVAPLSCIENLAB (9460, S. H. Behr) of 19 Mar 1964
(c) Conference at Telephonics Corp., Huntington, N. Y. of 20 Mar 1964 (S. Markowitz, Telephonics Corp. - J. Statz, A. S. & W. Co. - S. H. Behr, NAVAPLSCIENLAB- 9460)

FIGURE:

1- Photo No. L-19659-5 - Damaged Area of AN/SQA-13 Cable

1. As authorized under reference (a), the U. S. Naval Applied Science Laboratory is conducting investigations to improve the performance of electro-mechanical tow cables for variable depth sonar applications. This memorandum concerns an investigation of causes of conductor failure in an AN/SQA-13 tow cable removed from the USS SAUFLEY (DE-465) as reported under reference (b).

2. On the occasion of reference (c), the following background information was obtained:

a. The cable was installed on the USS SAUFLEY in December 1963 and was used for a total of about four weeks of towing operations without mechanical termination or electrical conductor malfunctions in the cable.

b. After the above towing operations, the feasibility of a shipboard installation of a mechanical end fitting was demonstrated by the Telephonics Corp. This was accomplished by removing the mechanical termination, unreeling 30 feet of cable from the drum and prestressing a new cone fitting on the cable under a tensile load of 12000 pounds applied by the drum winch. All conductors were continuous both under this load and after the tension was released.

c. During subsequent towing operations broken conductors were indicated by an irregular beam pattern on the sonar scope.

3. Twenty-five feet of cable from the cone location on the tow line were dissected and examined on the occasion of reference (c) and revealed the following:

a. Six feet from cone location- (See Fig. 1)
6 Outer layer conductors broken
7 Inner layer conductors broken
Center conductor- Insulation cracked in two places at kink (knuckle). All strands broken under insulation and fatigue type rupture indicated.

b. There were three other kinks in the center conductor in the 25-foot length. The three kinks as measured from the rupture in the conductor were four to five feet apart. The two layers of small conductors were displaced at the kink locations but were not damaged or broken.

4. The Telephonics Corporation had another reel of unused AN/SQA-13 cable at their plant that was manufactured in the same lot as the defective cable. Dissection and examination of a 20-foot length of this cable did not reveal any kinks in the center conductor. A 50-foot length of this cable was forwarded to the Applied Science Laboratory for further investigation.

5. The 50-foot length of unused cable was compared to a random length of used AN/SQA-13 cable available at this Laboratory that had been removed from a ship because of excessive armor corrosion. The make-up dimensions of both cables were similar and minor variations were considered normal for expected manufacturing tolerances. However, the new cable did contain approximately 20% more valley sealing compound per unit length than the used cable.

6. The cables were flexed over a 30-inch diameter sheave under a tension of 10000 pounds in a wire rope fatigue machine. The cable was in contact with 180 degrees of the sheave surface and the cable motion was reciprocating (10 cpm) with a three foot travel. The cable specimens were approximately 12½ feet in length and the armor wires were socketed with epoxy resin. The continuity of all conductors was monitored with pilot lights during operation. The results follow:

a. Used AN/SQA-13 cable with corroded armor- The specimen was subjected to 5000 reciprocating cycles and there was no indication of conductor discontinuity, no apparent external damage and no significant change in conductor resistance. Dissection and examination of the electrical core of the cable showed no derangement or damage to components or conductor kinks. However, grooves had worn in the steel at the contact surface between the inner and outer armor wires indicating the severity of the test.

b. Specimen #1 of the new AN/SQA-13 cable of the same lot as the defective cable from the USS SAUFLEY - At approximately 1000 cycles the valley sealer filler compound exuded through the spaces between the armor wires. The test was discontinued at 1500 cycles and at this time a relatively large amount of compound had exuded in several locations in the flexed area. There was no indication of broken conductors during the 1500 cycles of flexing. The cable was dissected and examined and there was no derangement or damage to the insulated conductors. The motion of the cable over the sheave while under compression had forced (milked) the sealing compound longitudinally through the cable core until it became blocked and inflated the sheath between the armor wires forming ridges in the sheath. The high pressure ruptured the sheath along the ridges and the compound exuded through pin size holes.

c. Specimen #2 of the new AN/SQA-13 cable of the same lot as the defective cable from the USS SAUFLEY- This specimen was subjected to 5000 cycles of flexing and the results and examination were the same as described in paragraph 5 b. above except that compound exudation through the spaces between armor wires started at approximately 300 flexing cycles.

7. A firm conclusion as to the cause for center conductor damage in the AN/SQA-13 cable removed from the USS SAUFLEY cannot be made based on the work done by this Laboratory. Investigations to simulate shipboard towing operations and duplicate kinks in the center conductor were limited by available apparatus which provided a maximum tensile force of approximately 10000 pounds, a maximum cable travel of three feet and a sheave diameter of 30 inches (Shipboard sheave is 26 inches in diameter). Furthermore, tow cables may be subjected to many stresses including transient surge loads, twist and extreme flexing unknown to the operator under towing conditions.

8. To form a conductor kink (knuckle), three primary conditions are required; a. The conductor must be located within a closely confined area. b. The conductor must be movable longitudinally and restricted at more than one place along its length. c. The conductor must be subjected to compression in the movable section between restricted areas. The core of electro-mechanical tow cables is designed to run over sheaves. Relative motion between conductors in a confined area must occur when the cable bends over the sheave because of the increase in circumferential distances from the sheave surface to the outer cable surface. During the latter part of vehicle retrieval the cable passes over approximately 90 degrees of the sheave surface. The center conductor is being subjected to maximum tensile

forces in the sheave area at this time. The compressive force between the cable and the sheave surface applies a gripping action on the center conductor which is transmitted by the surrounding members of the cable. This restriction of center conductor movement apparently produces a cumulative lengthening effect of the center conductor in the region between the sheave and the vehicle that can only be relieved by the knuckling action previously described. The question arises as to what conditions restricted the center conductor movement in this particular cable to a degree that it would not move in or beyond the sheave area. Any source of force which applies a strong circumferential squeeze on the cable core appears to be an obvious answer. Of the many possible conditions that could cause external pressure on the cable core and compact it, the following appear most likely:

a. Armor wires applied excessively tight during the manufacturing process.

b. Reduction in helix diameter of the formed armor wires by excessive tension in the cable during towing operations.

c. Excessive compression (flattening of cable) when running over the outboard sheave or drum while the cable is subjected to high tension.

In an attempt to verify the existance of some of these conditions, the armor wires of the AN/SQA-13 cable were examined. Although the degree of tightness of armor wire is often difficult to estimate, that of the cable under investigation did not appear to have been applied excessively tight during manufacturing. Conditions b. and c. above concerning excessive cable tension during towing or vehicle handling operations are, of course, unknown. The fact that the cable kinks appeared only in the last 25 feet of cable near the vehicle end indicates that the cable may have experienced excessive tension or crushing forces during initial step of launching or final step of retrieving operations during which time vehicle handling, especially in moderate to high sea states, is most difficult.

9. Although the center conductor kinks could not be duplicated in this Laboratory with existing test equipment, a further study will be made of the conductor problem with a VDS cable flexing machine now under construction that is expected to be in operation by 1 January 1965.

The fatigue investigation conducted on this AN/SQA-13 cable ruptured the cable sheath because of internal pressure caused by migrating sealing compound. This demonstrates a need for an improved sealing material and more durable sheaths. Experimental VDS cable samples with an elastomeric sealer and reinforced sheaths are being procured to improve the performance of VDS cables.

U.S. NAVAL APPLIED SCIENCE LABORATORY

LAB. PROJECT 9400-53
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FIGURE 1
AN/SQA-13 CABLE

OUTER LAYER CONDUCTORS - SIX BROKEN (VIEW #1)

OUTER LAYER CONDUCTORS - (VIEW #2)

INNER LAYER CONDUCTORS - SEVEN BROKEN

CENTER CONDUCTOR - TWO INSULATION CRACKS and TWO CONDUCTOR BREAKS (ALL STRANDS)

CENTER CONDUCTOR - INSULATION REMOVED